

CLAIMS

What is claimed is:

1. A method for forming damascene features in a dielectric layer over a barrier layer over a substrate, comprising:

5 etching a plurality of vias in the dielectric layer to the barrier layer with a plasma etching process in the plasma processing chamber;

 forming a patterned photoresist layer with a trench pattern;

 within a single plasma process chamber providing a combination via plug deposition to form plugs in the vias over the barrier layer and trench etch.

10

2. The method, as recited in claim 1, wherein the via plugs are formed by a plasma deposition.

15 3. The method, as recited in claim 2, wherein the via plugs are made of a fluorocarbon polymer.

4. The method, as recited in claim 3, further comprising a photoresist and via plug strip within the plasma process chamber subsequent to the providing the combination via plug deposition and trench etch.

20

5. The method, as recited in claim 4, further comprising opening a barrier layer within the plasma process chamber subsequent to the photoresist and via plug strip.

6. The method, as recited in claim 5, further comprising a depositing a feature barrier layer subsequent to opening the barrier layer, wherein the feature barrier layer is deposited over the substrate when the substrate is within the plasma process chamber.

7. The method, as recited in claim 5, wherein the providing the combination via plug deposition to form plugs in the vias and trench etch, comprises providing a plug forming gas and an active etchant in the plasma process chamber simultaneously and forming a plasma from the plug forming gas and the active etchant.

8. The method, as recited in claim 5, wherein the providing the combination via plug deposition to form plugs in the vias and trench etch, comprises providing a cyclic process with a via plug formation phase and a trench etch phase, wherein the cycle is performed more than three times.

9. The method, as recited in claim 8, wherein in the via plug formation phase comprises:

providing a via plug formation gas comprising C_4F_8 , CH_2F_2 , Ar, and O_2 to the plasma process chamber; and

forming a plasma from the via plug formation gas; and

wherein the trench etch phase, comprises:

providing a trench etch gas comprising CF_4 , CHF_3 , and O_2 to the plasma process chamber; and

forming a plasma from the via plug formation gas.

10. The method, as recited in claim 5, wherein the plasma deposition forming
the via plugs deposits more on the bottoms of the vias than on sidewalls of the
5 vias.

11. The method, as recited in claim 5, wherein the photoresist and via plug
strip is provided by an ashing process.

10 12. The method, as recited in claim 11, wherein the ashing process is selected
from the group of an O₂ based ashing and an N₂ / H₂ based ashing.

13. The method, as recited in claim 5, wherein the providing a combination via
plug deposition and trench etch, comprises providing a gas selected from the
15 group comprising a fluorocarbon and a hydrofluorocarbon.

14. The method, as recited in claim 12, wherein the gas further comprises an
inert carrier gas and an additive gas selected from the group comprising oxygen
and hydrogen.

20

15. The method, as recited in claim 2, wherein each of the plurality of vias
have sidewalls and bottoms, wherein the via plug deposition deposits a thicker
layer on the bottoms of the vias than on the sidewalls.

16. A semiconductor device formed by the method as recited in claim 1.
17. An apparatus for forming damascene features in a substrate, comprising
- 5 a plasma processing chamber;
- a gas source connected to the plasma processing chamber, for providing a gas to the plasma processing chamber;
- a plasma excitation power source connected to the plasma processing chamber for generating and maintaining a plasma within the processing chamber; and
- 10 a controller for controlling the gas source and the power source, comprising computer readable instructions, comprising:
- computer code for signaling to the gas source to provide a via plug deposition gas from the gas source;
- computer code for signaling to the plasma excitation power source
- 15 to provide power to transforming the via plug deposition gas into a plasma to form via plugs, which selectively deposits preferentially on bottoms of vias over sidewalls of vias;
- computer code for signaling to the gas source to provide a trench etching gas from the gas source; and
- 20 computer code for signal to the gas source to provide a plug strip gas from the gas source after the trench etch is performed.
18. The apparatus, as recited in claim 17, wherein the gas source comprises:
- a via plug deposition gas source;

a trench etch gas source; and

a plug strip gas source.

19. The apparatus, as recited in claim 18, wherein the via plug deposition gas
5 source comprises a hydrofluorocarbon gas source with additive gases.